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BARN AND FIELD EXPERIMENTS IN 1916

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AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

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†In collaboration with U. S. Department of Agriculture.

BULLETIN 260

BARN AND FIELD EXPERIMENTS IN 1916.

REPORTED BY CHAS. D. WOODS.

The work of investigation at the two experiment station farms (Aroostook Farm, Presque Isle, and Highmoor Farm, Monmouth) is planned by the Director, the Biologists, the Plant Pathologist and the Entomologist. The results of the more scientific phases of the studies are reported from time to time in the bulletins, but it always happens that there are results obtained that lie somewhat outside of the lines of work of any of the Station specialists. Some of the more popular and practical results are here reported. The carrying out of these experiments and the taking of the requisite notes devolved upon different members of the Staff.

DRAWING CONCLUSIONS FROM FIELD EXPERIMENTS

Field experiments at the best are somewhat uncertain because there are so many factors of soil, temperature, rainfall, and the like, that affect the results which are beyond the control of the experimenter. In like manner ordinary feeding and other experiments with animals are outside of laboratory control and are beset with uncertainties that render conclusions more or less uncertain. It is, therefore, always planned at this Station to carry the same experiment under as nearly as possible the same conditions through a series of years before attempting to draw any very definite conclusions. The results here reported should be considered more in the light of reports of progress than of completed studies. It may happen that the teaching that a single year's results seem to warrant may be reversed by the repetition of the experiment in other years under different climatic or other conditions.

ARE SHEEP PROFITABLE IN WINTER?

The Station Council, at its meeting in April 1914, authorized the purchase of grade sheep sufficient to stock Highmoor Farm for the purpose of studying the question as to whether sheep can or cannot be profitably raised in Maine. The sheep were not to be of a fancy type, or be pure bred so that none of the animals could be sold at a fancy price. Nor were they to be early bred to produce "hot house" lambs for the high price of the early market. They were to be just plain sheep such as any ordinary farmer could carry. While care was to be exercised in handling the sheep, no high priced labor was to be used. Nor was a special "shepherd" to be employed.

The sheep are grade Hampshire, but are so nearly pure Hampshire that only an expert could tell them from pure bloods. They are as fine a flock of sheep as one cares to see. The farm superintendent is an experienced man with sheep and they have excellent care. A year ago the results of the first year's trial were published in Bulletin 246. This trial showed that the sheep were kept at a large loss. This publication led to the receipt of many letters and to the publication of some newspaper articles. It was evident from these that many owners thought they were making money from sheep. But no one was found who was keeping a flock of about 100 sheep who knew from actual figures whether they were or were not being kept at a profit. At the recent convention of the State Dairymen's Association a paper was read that showed a profit on a small flock, but many of the data cited were estimates.

It is probably true that on most farms a few sheep would be profitable, because they would be cared for in time that otherwise would not be profitably employed, and the sheep would be fed more or less of unmarketable produce and hay. A set of books in which everything was charged and credited would probably not show the balance on the credit side. Nevertheless, most farmers who are equipped for them would be better off with a few sheep, because of the salvage of time and materials that might otherwise be wasted. Thus with sheep it is the same as it is in the case of a few swine, a small flock of hens, a small area devoted to garden crops, etc. With certain well known exceptions, very few of the farm items, charging

labor at what it costs, food at what it is worth, and taking fixed charges into account, would show book profit. Nevertheless, on every hand there are farmers who with incomes derived from small flocks, small herds, and small areas devoted to crops, live comfortably, educate their children, and accumulate some bank surplus.

There will always be an expense for fitting up and maintaining pastures, buildings, etc., for sheep that will vary on different farms and with different farmers. The overhead charges, such as interest, taxes, and the like, will also vary with varying conditions. In an experiment conducted by the Station, where it is necessary to keep individual records, buttons for the ears and time involved in note taking are expense items that the ordinary farmer need not be at. For these and similar reasons the cost of fencing the pastures, erecting shelters in the pastures, fitting up the barns for winter quarters, expenses for piping water, water troughs, sheep dipping tanks, shearing machine, gas engine, root cutter, rent of land for pastures and crops for the sheep, while necessary expenses that must be taken into accout by the practical farmer, are omitted from the following statement. The amounts included are the inventory value of the sheep, the cost of labor in caring for the sheep, cost of the food purchased, the value of the hay and straw at the barn, the cost to grow the roots used. The credits are the sheep and wool sold and the inventory at the end of the year.

As reported in Bullentin 246, the year as given ran from July 1 to June 30. This is the fiscal year as prescribed by the State Auditor, but is not a good one for an experiment of this kind which far more naturally begins and ends either with turning the sheep out to pasture in the spring, or, still better, with the housing of the sheep in the fall. In order to make it possible to include practically all the income from the sheep within the year, the duration of the year is changed so that it now runs for 12 months from the first of November, instead of the first of July. In order to compare fairly the first report as given has been changed so as to make it begin November 1, 1914, instead of July 1, 1914, as it was previously reported. The tabulations that follow give two years expenditures and receipts begining November 1, and ending October 31, for each year

*Sheep Account for Year Nov. 1, 1914, to Oct. 31, 1915**

Inventory and Expenditures.

73 ewes at $5	$ 365.00
22 ewe lambs @ $3	66.00
3 bucks at $25	75.00
Bran and middlings, 7000 pounds at $30 per ton	105.00
Oil meal, 800 pounds at $37 per ton	14.80
Corn meal, 2400 pounds at $32 per ton	39.40
Gluten feed, 100 pounds at $36 per ton	1.80
Ground oats, 44 bushels at 55 cents per bushel	24.20
Hay, 45,600 pounds at $12 per ton	273.60
Straw, 6,000 pounds at $5 per ton	15.00
Turnips, 515 bushels at 10¢ a bushel	51.50
Dips, etc.	10.96
895 hours man labor on sheep at 17½¢ per hour	156.62
3 hours horse labor at 15¢ per hour	.45
	$1,198.33

Receipts and Inventory.

Sheep and lambs sold	$ 115.69
Wool sold	170.09
Manure**	36.00
47 old ewes on hand Oct. 31, 1915, at $5	235.00
22 yearling ewes on hand Oct. 31, 1915, at $5	110.00
33 ewe lambs on hand Oct. 31, 1915, at $3	99.00
3 registered bucks on hand Oct. 31, 1915	75.00
Loss on operation for year	375.55
	$1,198.33

*Pasturage, use of land for crops and buildings for summer shelter and winter housing, interest on investment and other overhead charges are not included in this account.

**Manure as valued by farm superintendent's estimate when drawn from the barns and sheds.

*Sheep Account for Year Nov. 1, 1915, to Oct. 31, 1916**

Inventory and Expenditures.

47 original purchase ewes at $5	$ 235.00
22 yearling ewes (1914 lambs) at $5	110.00
33 ewe (1915) lambs at $3	99.00
3 registered bucks at $25 (Sold in January 1916)	75.00
2 registered bucks at $25 (Purchased in October 1916)	50.00
Bran, and mixed feed, 5,500 pounds at $27 per ton	74.25
Oil meal, 475 pounds at $40 per ton	9.50
Corn meal, 1900 pounds at $31 per ton	29.45
Gluten feed, 200 pounds at $36 per ton	3.60
Ground oats, 67.5 bushels at 65 cents per bushel	43.88
Hay, 48,135 pounds at $15 per ton	361.01
Rowen hay, 4,800 pounds at $12 per ton	28.80
Straw, 8,675 pounds at $5 per ton	21.69
Turnips, 570 bushels at 15¢ per bushel	85.50
Cull apples, 3 tons at $4 per ton	12.00
Dips, $6.00: Medicines, $1.50	7.50
Salt, 2 bushels at 35¢ per bushel	.70
853 hours man labor at 18¢	153.54
19 gallons gasoline at 27¢ per gallon	5.13
Total	$1,405.55

Receipts and Inventory

Wool		$ 255.91
Sheep and lambs sold		491.08
63 tons manure from pit 12 tons manure from sheds	See discussion	
38 original purchase ewes 7 1914 ewes 22 1915 ewes	67 at $5	335.00
20 1916 ewe lambs at $3		60.00
2 registered Hampshire bucks at $25		50.00
1 Hampshire buck obtained in exchange for 2 ewe lambs		6.00
Loss on operation**		207.56
Total		$1,405.55

*Same as first foot note on page 88.

**This is the loss without allowing for value of manure. See discussion in text.

THE EXPENDITURES

The inventory of the flock is at a much lower price than they could be purchased for or than they would be sold for. This bears only slightly on the experiment as the numbers of the sheep are kept fairly constant year after year. Rather more sheep were carried through the winter of 1915-16 than would usually be the case.

No account is taken of the feed consumed from the three pastures aggregating about 100 acres. Nor is rental charged for land used in growing crops such as rape and turnips for the use of the sheep. The concentrated feeds are charged at about the average cost for each year, but this dos not include freight or cartage. The hay and straw are priced at what they would have sold for at the barn each year. The turnips are charged at what it costs to grow them without any overhead charges. The season of 1915 was not a favorable one at Highmoor Farm for growing turnips and they cost a half as much again as they did the preceding year. A lessened yield and greater labor cost due to the character of the season explains this increase in cost of production. In 1914-15 the sheep were fed about 120 pounds of grain, 460 pounds of hay, and 320 pounds of turnips per head, and about 60 pounds of straw were used per sheep. In 1915-16 they were fed about 100 pounds of grain, 500 pounds of hay and 390 pounds of apples and turnips. The grain cost about $1.90, the hay $2.80, and the turnips $0.55 per head in 1914-15. In 1915-16 the grain cost about $1.40, the hay $3.75, and the turnips and apples nearly $1.00 per head. The total cost of food and straw in 1914-15 was about $5.35 per head, and in 1915-16 it was $6.40.

The only labor charged against the sheep is the actual time used in care, as feeding, shearing, etc. The work of keeping up pasture fences, buildings, making records, and other things incident to the experimental side that does not directly apply to the sheep, is not included in the tabulation. The cost for labor per sheep was, in round numbers, $1.50 each year. The total cost per head, for maintenance, excluding inventory for the 98 sheep in 1914-15, was $7.06 and in 1915-16 it was $8.04 for each of the 104 head.

The losses from death and accident were slight in each year and were mostly lambs that were still born or weak at birth.

Receipts.

The wool and lambs sold each year were probably as well marketed as the average farmer could expect unless he put a good deal of his own time (and in the case of the Station that means added cost) into finding a market. No attempt to market in any unusual way was attempted as that would have been contrary to the plan of the experiment. The sales per head in 1914-15 averaged a little under $3 and in 1915-16 a little over $7. This difference was due to a larger number of lambs, their higher selling price, a heavier clip of wool and its very high price. In the spring of 1915, 67 strong lambs were dropped by ewes and in the spring of 1916 there were 80 strong lambs. The clip averaged 5.7 pounds per head in the spring of 1915 and 6.4 pounds in the spring of 1916.

In 1914-15 the manure was left under the sheep during the winter, as is customary with all handlers of sheep the writer has knowledge of in the East or the Middle West. It is commonly supposed that the compacting of the manure by the sheep treading upon it and the moistening from the urine will prevent losses. The value of the manure in 1914-15 was from estimates by the farm superintendent as to what we would be willing to pay for the manure if we were buying it. It may be that the farm superintendent underestimated the value of the sheep manure from the barn and yard and that it was worth more than was credited. As it is not the fault of the sheep if faulty handling of the manure results in loss, the attempt to guard against loss was made in 1915-16. The methods used are given on pages 94-99 beyond.

In 1915-16 there were produced 75 tons of manure which contained nitrogen, phosphoric acid and potash worth, at the valuation used for commercial fertilizers in 1914 (before the war prices) about $300. The labor cost, teams and men, for moving the manure monthly to the manure platform for working over by swine, was about $25. The net value of the plant food in the manure at the barn was, therefore, about $275.

Without considering the value of the manure on the credit side, or any overhead charges such as interest on investment, depreciation of plant, pasturage and taxes, there was a net loss of a little over $200 for the year's operation. Allowing full credit for the manure and omitting overhead charges would show a credit balance of about $100.

Careful attention has been given to all criticisms that have been at all suggestive of better ways of handling the flock. Although there seems to be no reason to expect more favorable results than have been obtained in 1915-16, the experiment is being continued. The high prices for wool and lambs were favorable in 1915-16 and probably will be equally favorable this year. Hay is worth only about two-thirds as much as in 1915-16. Grain is some higher in cost, as also is labor. But on the whole if the prices that are likely to prevail this year were substituted for those that did prevail in 1915-16 the income would have prettly nearly equalled the outgo without giving any credit for the manure. Whenever an animal husbandry project will pay all costs of food and care from the sales and the manure is left as a profit it can be classed as a profitable enterprise. For the production and conservation of manure is as truly an asset in New England agriculture as for generations it has been reckoned to be in European countries.

ARE SWINE PROFITABLE IN WINTER?

In the experiment on the care of manure discussed beyond it was necessary to keep it well worked over and at the same time compacted so as to prevent losses from heating. It was thought that swine might do the work at far less cost than man labor. As shown below this surmise was correct, for instead of having a labor bill to charge against the manure the swine made a profit.

A brood sow and 14 two-months old pigs were placed on the manure December 1, 1915, and were kept there until June 7, 1916. The swine were fed and handled as the superintendent found convenient. That is, there was no definite program for feeding decided upon and therefore it varied more or less from time to time. Although experiments conducted at the Maine Station 25 years ago make it doubtful if there is a profit in feed-

ing cooked roots, the swine were fed a mash composed of cooked turnips and ground feed as long as the turnips lasted. Some whole corn was scattered over the manure at times in order to keep the swine at work stirring the manure. During the rather more than 6 months the swine were fed 10,850 pounds of turnips, 1100 pounds of corn meal, 600 pounds of whole corn and 2100 pounds of middlings and bran. The bran was used only when there were no middlings available. It took 155 hours of the chore boy to cook the mash and feed and otherwise care for the swine.

The season of 1915 was not a good one in which to grow turnips at Highmoor Farm and it cost 15 cents a busel to grow them that year. In 1914 it cost 10 cents a bushel at Highmoor Farm, and in some cooperative experiments in Washington County turnips were grown that year for less than 8 cents per bushel. Grain and mill feeds were high during the winter of 1916, though the prices dropped as warm weather came on. Reckoning the turnips at 15 cents a bushel, the corn at $30 per ton, the corn meal at $31 and the middlings at $27 per ton, the feed used cost $81.53. Reckoning the time of the chore boy at 15 cents per hour the labor cost was $23.25. The sow was worth $15 and the pigs $2.50 each when the experiment began, a total of $50 for the cost of the swine. The total cost, for the swine, their feed, and care, at the above prices, was $154.78.

At the end of the experiment the sow weighed 270 pounds, and the pigs averaged 114 pounds each. None of these were fat, but were "store pigs" and were worth 8 cents a pound live weight in June. The total selling value of the swine at the end of the experiment was $149.28. It was planned to have the sow produce a litter of pigs in May. For some unexplained reason the pigs were, with one exception, born dead. This is no fault of the experiment, and hence in fairness the receipts should be increased by an average litter of 8 pigs worth $2 each. The plant food in the feed consumed at normal prices for nitrogen, phosphoric acid, and potash, was worth $27. The swine should be credited with at least half of that amount. The corrected, complete returns were, therefore, in addition to having the manure thoroughly worked and in excellent shape for application to the land, $178.46. This gave a profit of $23.68, a return of 15 per cent of the total expenditure. Winter

is not the time of the year in which it is supposed there is profit in swine in Maine. It is not claimed that these swine were handled in the best or the most economical way. Certainly turnips at 15 cents a bushel do not furnish protein and carbohydrates at a very moderate cost. Not taking into account the cost of getting the turnips from the storage and cooking them, the nutrients furnished by the turnips at a cost of $27 could have been purchased in the form of corn and middlings for two-thirds that price. That is, to compete with the price of mill feeds in the winter of 1916 turnips would need to be grown at a cost of about 10 cents per bushel in the celler. Bran is probably not an economical feed for swine.

This one trial would seem to indicate that swine may be kept in this State at a profit in winter. An all-the-year round experiment with swine, where the chief growth of the young pigs would be made on pasture—fall sown rye, rape, clover, etc.—would probably prove swine to be one of the most, if not the most, profitable kind of farm live stock in Maine.

THE WINTER HANDELING OF FARM MANURE.

While it is probably true that the quicker manure can be applied to the land the less is the waste, even though the application is made after the ground is frozen, the fact remains that in Maine it is usually necessary to store the droppings during the winter months. Also it is usually not practicable to apply manure to land during the height of the growing season. It is estimated that approximately 75 per cent of the plant food contained in the feeding stuffs used are in the dung and urine voided. As usually handled, much of this is lost. As pointed out in the report of the Sheep Husbandry experiment in Bulletin 246 there were apparently large losses from the stored manure. In examining the data it was found that the plant food in the feed consumed while the sheep were confined to their winter quarters was worth at ordinary fertilizer prices in the neighborhood of $200 and that the manure from the sheep was valued by the farm superintendent as worth about one-eight of that sum. The manure was left under the sheep in the same way that is practiced by farmers everywhere, so far as the wri-

ter knows, in the East and the Middle West. Inquiry among sheep men discloses the fact that they are not sure about the losses that may result from this method of handling sheep manure.

In order to study this question an experiment was started in the fall of 1915 which involved the construction of a suitable manure pit and led to a trial of winter feeding of swine, and an experiment in the care and handling of ordinary mixed manure from cows and horses as well as the handling of sheep manure for which the experiment was originally planned.

The Manure Pit.

The manure pit, if a structure above ground can be called a pit, is built beneath a shed. It is of cement construction; 33 by 30 feet, with walls of cement 18 inches high above the floor. A partition wall of the same height divides the pit into two equal parts. One-half was used for the experiment with sheep manure and the other half for that with the cow and horse manure. The sides above the concrete are temporary and made of rough boarding. It is not necessary to carry the walls higher than 18 inches as the liquid will never accumulate to that depth. The movable wooden sides make loading the manure from the pit easy. The cement floor is four inches thick and the cement walls taper from 8 inches at the bottom to 6 inches in thickness at the top. The floor inclines toward one corner at the middle partition where there is a partition so that if liquid accumulates too fast in the manure it will drain to these pockets. If the top is too dry the liquid from the manure can be readily pumped to the dry portions or if the top is too dry and no liquid has accumulated, the manure can be wet with water.

It took 15 horse days, chiefly drawing gravel and sand for the concrete work, 58½ man days and 120 bags (30 barrels) of cement to construct the pit. The cost for everything, at prices that prevailed in the fall of 1915, was a little less than $200.

THE EXPERIMENT AT HIGHMOOR FARM IN 1915-16.

As previously stated, in the experiment in sheep husbandry begun in 1914 an apparently large waste of the plant food contained in the feeds was observed when the manure was kept under the sheep during the winter. As the value of the manure is of great importance in the margin between profit and loss an experiment was planned and conducted during the winter of 1915-16 so that the manure would be stored under what seemed to be the best conditions practicable. The plan was to keep account of all food eaten, store the manure in a water-tight manure platform, keep it worked by swine so as to prevent fire-fanging. As there are two cows and three horses kept during the winter at the farm, the manure platform was built in two sections so that an experiment with this mixed manure could be carried on at the same time as that from the sheep.

The feed and bedding used by the about 100 sheep consisted of 52,575 pounds of mixed hay, 7,075 pounds oat straw, 6,000 pounds cull apples, 34,150 pounds rutabaga turnips, 4,700 pounds bran, 600 pounds middlings, 1,500 pounds corn meal, 2,160 pounds oats, 475 pounds linseed meal, and 200 pounds of gluten meal. The cows and the horses used 24,650 pounds mixed hay, 3,250 pounds straw, 1,000 pounds bran, 1,300 pounds corn meal and cracked corn, 4,625 pounds oats, 300 pounds gluten meal, 300 pounds linseed meal and 100 pounds middlings. A bunch of swine was kept on the manure so that they could go from one part of the manure platform to the other. They were fed 10,850 pounds rutabagas, 1,700 pounds corn, 1,600 pounds middlings and 500 pounds bran. As the droppings from the swine were from the most part made on the sheep manure part of the platform, the plant food in their feed was added to that of the sheep.

The feeding stuffs were not sampled and analyzed but their plant food content was computed from average analyses of similar materials. The manure was weighed when it was drawn to the fields and each load was sampled. The final composite sample of each kind of manure was analyzed, with the following results:

Composition of the manure as removed from the pit.

	Nitrogen Per Cent	Phosphoric Acid Per Cent	Potash Per Cent
Mixed Manure. (Cows, Horses, Hogs)	0.457	0.19	0.50
Sheep Manure (with Hogs)	0.74	0.29	1.04

The feed (including that of the swine) and the bedding for the sheep carried approximately 1177 pounds nitrogen, 564 pounds phosphoric acid and 1485 pounds potash. The sheep manure weighed 125,705 pounds and carried 931 pounds of nitrogen, 490 pounds of phosphoric acid and 1307 pounds of potash.

The feed and bedding for the horses and cows carried 529 pounds of nitrogen, 207 pounds phosphoric acid and 576 pounds potash. The mixed manure weighed 76,870 pounds and carried 351 pounds of nitrogen, 146 pounds of phosphoric acid and 384 pounds of potash.

Seventy-nine per cent of the nitrogen, 87 per cent of the phosphoric acid and 87 per cent of the potash in the feeding stuffs used were found in the sheep manure and 61 per cent of the nitrogen, 56 per cent of the phosphoric acid and 67 per cent of the potash in the food and bedding given the cows and horses was found in the mixed manure. In the case of the sheep the amount of plant food recovered in the manure agrees very well indeed with the experiments that have been made where the excreta have been collected, weighed and analyzed immediately. In the case of the mixed manure, the trough behind the cows was not water tight and there were not sufficient absorbents used to take up all the liquid excreta. Also the horses were used more or less upon the road and their droppings when they were out of the barn were lost.

On the whole, the manure platform described above has worked satisfactorily. It was not expensive to construct, the swine used to work the manure showed a profit after all food and labor were charged to them, and apparently the manure was kept with a very small loss of plant food. In Maine for the six months of the year when it is not practicable to draw the manure and apply it to the land as fast as it is made, this meth-

od affords a satisfactory and economical way of conserving the plant food in the feeds used. It is a conservative estimate, then, that the plant food in the manure annually voided by farm animals and poultry in Maine has a potential value of about ten millions of dollars and that it is doubtful if by present methods of care even one-half of this plant food is actually returned to the soil. These trials with the manure platform and swine indicate that by a little care most of this plant food can be conserved and that the profit on the swine will make good returns on the investment and the added plant food saved will all be clear profit. And this conserved plant food will in many cases be the difference between keeping livestock at a profit or keeping them at a loss.

WHAT IS FARM MANURE WORTH TO THE FARMER?

The Ohio Experiment Station has carried extensive comparative experiments with farm and commercial manures for many years. Recently Director Thorne wrote: "After more than twenty years' work in the comparison of manure and chemical fertilizers on many crops, the Station is not able to credit manure with any value beyond that of the nitrogen, phosphorus, potassium and lime which it carries." "When manure costs more than two dollars per ton spread on the land, it is wiser to use the chemical fertilizers mentioned than to buy manure."

In addition to the nitrogen, phosphoric acid and potash which farm manure supplies it also carries a large amount of organic matter which is important in increasing the productivity of the soil. As this vegetable matter breaks down in the soil the acid products thus formed helped to dissolve and make available to plants some of the otherwise insoluble plant food in the soil. Farm manures teem with bacteria of various kinds which cause chemical changes not only in the manure, but in the soil itself, converting insoluble plant food into forms available for the use of crops. The humus formed from the organic matter of farm manure improves the soil texture, helps retain moisture, and is valuable in many ways. Its plant food is not so quickly nor so completely available as in the better forms of chemicals. But after much balancing of the

pros and cons it has become generally accepted that the commercial value of the plant food contained is the only definite thing about a farm manure by which we can measure its agricultural and commercial value.

The sheep manure, together with the straw bedding as worked over by swine at Highmoor Farm carried .74 per cent nitrogen, .29 per cent phosphoric acid and 1.04 per cent potash. The mixed manure and bedding from three horses and two cows also worked over by swine carried .46 per cent nitrogen, .19 per cent phosphoric acid and .50 per cent potash. At the commercial values placed upon chemical fertilizers in 1914* the plant food carried by a ton of the sheep and swine manure was worth $4.16 and in a ton of the mixed manure $2.44.

Assuming that two men and one double team can load, draw to the (not too distant) field and spread eight tons of farm manure a day it would cost about 75 cents a ton to apply the manure to the land. Deducting the cost of application, a ton of the sheep and swine manure had a value at the barn of about $3.40 and of the mixed manure of $1.70, per ton. Each of these lots weighed about 3500 pounds to the cord. Therefore the sheep and swine manure was worth about 6 dollars a cord and the mixed manure about 3 dollars a cord at the manure pit.

FERTILIZER EXPERIMENTS ON APPLE TREES AT HIGHMOOR FARM.

As it is pretty generally known, when the State purchased Highmoor Farm it had something over 3,500 apple trees upon it. These trees were about twenty-five years old, but for the most part had been completely neglected, as regards pruning, fertilization, culture and spraying. The first season that the Station had the farm the orchards were plowed, cultivated and sprayed. Pruning was begun and has been continued until at the present time the orchards are in pretty fair shape. It was, of course, not desirable or practical to thin the trees out at the start to where they should be at the end, but the pruning while rather severe each year has been gradually decreased in amount.

The orchards were annually fertilized at the rate of 1,000 pounds per acre of a commercial fertilizer carrying 4 per cent

*It has seemed fairer to use in this discussion the prices prevailing before the war.

of nitrogen, 8 per cent of available phosphoric acid and 7 per cent potash. At the end of the third year the orchards had so far responded that they gave a good crop and since that time fertilizer experiments have been carried on in various portions of the orchards, as follows:

The use of highly nitrogenous fertilizers has been advocated as a means of forcing trees into bearing and in some parts of the State has been tried with results that seemed to be gratifying. This method was first suggested by Doctor Fisher of Massachusetts and was tried by the Station several years ago in cooperative work with Mr. Pope in his orchard at Manchester without very decisive results. At Highmoor Farm a row of 32 Baldwin trees was divided into three sections. The trees were treated alike so far as the application of standard fertilizer was concerned, but 10 of the trees at each end of the row received in addition nitrate of soda at the rate of 100 pounds per acre. Also the Baldwin orchard was divided into two parts so that part of it received the usual treatment and in addition received 100 pounds of nitrate of soda per acre per year.

Exact records of yields and measurements of growth have been taken since the experiment was begun. No differences that could be attributed to the additional nitrogen in the fertilizer have been noticed. It may be that when at the end of a period of years the data are carefully analyzed, results may be found that are not noticeable from general observations. The experiment is being continued.

In experiments carried out at the New York State Experiment Station it has been found that with their deep clay soils well suited to apple tree growth and apple bearing, there is no effect from the use of fertilizers either upon the growth of young trees, the wood growth on matured trees, or in the amount, coloring, or size of the fruit. To see if anything like this would hold with Maine conditions, particularly with the rather shallow soil and with the stubborn subsoil upon Highmoor Farm, an experiment was begun in 1912. It is to be remembered that the orchard had been cultivated and fertilized for the three preceding years and brought into good condition. About 400 trees were divided into three plots containing 12 rows extending clear across the large No. 1, Ben Davis orchard. Plot A (rows 1 to 4) has received no fertilizer since 1912. Plot B (rows 5

to 8) has received annually since 1912, 500 pounds per acre of a fertilizer carrying 4 per cent of nitrogen, 8 per cent of available phosphoric acid and 7 per cent of potash. Plot C (rows 9 to 12) has received annually since 1912, 1,000 pounds per acre of a commercial fertilizer carrying 4 per cent of nitrogen, 8 per cent of available phosphoric acid and 7 per cent of potash.

Careful records of growth shown by measure, and of yields of fruit as shown by weight, are made of all of the trees in the orchards at Highmoor Farm. No person examining the twelve rows of apple trees, part of which have been fully fertilized, part partially fertilized and part not fertilized at all for the past three years, could detect differences whereby he would be able to pick out the treated from the untreated rows.

Each tree occupies 25x25 ft. or 625 sq. ft. This is about 70 (69.5) trees per acre. At the rate of 1,000 lbs. per acre this is 14.4 lbs. per tree. Fertilizer at $40 per ton costs 2 cents a pound, making a total cost of 28.8 cents per tree, not allowing for the cost of application.

The crop on this orchard was too small in 1913 to give results that could have any meaning on the apple bearing of the trees. In 1914 and in 1915 there were fair crops and while from observation no differences were apparent, the actual yields of fruit were larger on the fertilized plots. The yields are given in the table that follows, but it will apparently be necessary to wait a number of years before decisive results are obtained. The yields show consistent increase with the amount of fertilizer applied.

Orchard Fertilizer Experiment. About 130 Ben Davis Apple Trees in each Plot. Average yield of apples in pounds per tree.

Year	Plot 6 A No fertilizer since 1912	Plot 6 B 7.2 pounds 5-8-7 fertilizer per tree	Plot 6 C 14.4 pounds 5-8-7 fertilizer per tree
1914	172.8	158.8	194.2
1915	121.1	131.8	157.4
1916	113.7	138.7	147.2
Average for 3 years	135.9	143.1	166.6

It is to be remembered that in all of these experiments nothing has been grown upon the land except apple trees and apples. An orchard cover crop of rye is sown in the fall, is plowed under early in the spring, and the land is kept cultivated until well into August when the cover crop is again sown. The plant food stored up in the wood growth and that which has been removed in the apple crop has been taken from the soil, but beyond that the soil has not been made to pay tribute to any other crop.

This experiment is to be continued for many years, or until decisive results are obtained and the unfertilized rows show evidence of need of plant food.

COMMERCIAL VARIETIES OF OATS AT AROOSTOOK FARM.

Experiments with oats were undertaken by the Maine Agricultural Experiment Station at Aroostook Farm in 1914. Two principal objects are in view in this work—first, to ascertain which of the more popular commercial varieties are best adapted to Aroostook conditions; and, second, to breed new varieties which will be still better adapted to those conditions than any now available. The work of breeding new varieties is under way, but is necessarily slow. It will be several years before any of the new varieties already produced will have been sufficiently tested to warrant distribution.

For several reasons the results obtained in 1914 were not entirely satisfactory. The farm was purchased very late in the fall of 1913 and there was little opportunity to learn anything by observation of the land until planting time was come. Because of everything being new to the staff it was impossible to get the oats planted as early as they should have been. The very loose character of the soil allowed the heavy disk drill used in seeding to put the seed too deeply in the ground. All of these things tended to lower the yields.

In 1915 the work at the Farm was very much better organized and more favorable results were obtained. Fifteen different varities were grown each in a single half acre plot. These varieties were all sown with a large disk drill. In order to prevent the seed going into the ground too deeply the land was rolled before drilling. The seeding was at the rate of 3 bushels per acre.

The detailed results of the experiment for 1915 were published in Bulletin 246.

In 1916 sixteen different varieties were tested. These included all the varieties grown in 1915 except Imported Scotch, and in addition two new varieties. One of these, known as Maine 340, was originated by the Maine Agricultural Experiment Station at Highmoor Farm. This variety has proven to be such an excellent oat for southern and central Maine that it was thought desirable to test it under Aroostook conditions. The other new variety is the Minnesota 26. This variety originated by the Minnesota Experiment Station has proven to be very good in the southern part of the State.

In the two preceding years each variety has been grown in a single plot of about one-half acre. Owing to the uneven nature of the land on Aroostook Farm the plot of one variety sometimes fell on very good soil and that of another variety on much poorer soil. In order to get around this difficulty each variety was sown in 1916 on 3 separate plots each located in a different part of the field. In this way there was much less chance of all the plots of the variety falling on very good or very poor soil. Each plot was 1-10 acre in area. The three plots thus making 3-10 of an acre for each variety. The yield of each variety is taken as the average of the 3 plots.

The yield of each variety expressed in bushels of oats and pounds of straw, and the average yield of grain for the two years 1915 and 1916 are given in the table which follows on page 104.

From this table it is seen that Maine 340 gave the best yield and for this season at least has shown itself superior to any of the other varieties. The Early Pearl and the Siberian have always been near the top of the list in our variety tests. The chief objection to these two varieties for Aroostook is their late maturity. These varieties are from 3 to 6 days later than Maine 340.

The early varieties such as Kherson and Daubeney will mature about a week or 10 days earlier than the others, but as shown by the table their yields are not so good as many of the others.

Varieties such as Garton No. 5, Swedish Select and Senator have been at the bottom of the list every year. We can be very

certain that these varieties are not well adapted to Aroostook conditions.

Yield Per Acre of Commercial Varieties of Oats Tested At Aroostook Farm 1915 and 1916.

Variety	2-year Average Bushels	1916 Yield	
		Grain Bushels per Acre	Straw Pounds per Acre
Maine 340		75.6	3868
Early Pearl	70.1	66.6	3268
Silver Mine	65.6	66.3	3267
Siberian	68.3	66.0	3389
Ligowo	63.1	64.3	3248
Minnesota 26		63.1	3177
Banner	59.2	62.5	3137
Prosperity	64.3	61.9	2970
Gold Rain	61.5	61.5	3757
Kherson	64.5	61.3	4091
Maine 346	60.4	59.5	2813
Irish Victor	55.4	57.3	3139
Daubeney	59.0	57.2	3979
Garton No. 5	54.9	56.9	3778
Swedish Select	53.0	56.5	3101
*Senator	47.8	*45.8	*3611
Average	60.5	61.4	3412

*One plot only, of Senator planted.

COMMERCIAL VARIETIES OF OATS GROWN AT HIGHMOOR FARM IN 1916.

The Maine Agricultural Experiment Station has been conducting tests of commercial varieties of oats at Highmoor Farm since 1910. The detailed results of these tests for the 4 years 1910 to 1913 inclusive were published in Bulletin 229, and the results of the 1915 tests were published in Bulletin 246.

The season of 1916 was very unfavorable for oats at Highmoor. The yields recorded are the lowest obtained in the 6 years that the Experiment Station has had the farm. A very severe rain storm in which 4.1 inches of water fell in 24 hours occurred on May 18. The oats were just well started at that time. All of the plots were badly washed and in some plots gullies 12 to 18 inches wide and almost as deep were washed out. Again just before harvest a very severe rain storm with some hail beat the oats down so that the yields were very seriously affected. The areas which were actually washed out in each plot were measured and some allowance made for these, but in some

plots the plants were washed worse than in others, and yet it was not practicable to estimate the exact amount of damage done.

In all, 18 different varieties were tested. Seven out of these are standard commercial varieties which have been tested by us for several years past and found to be exceptionally good. These varieties with their 1916 yields in bushels per acre are Early Pearl 56.7; Irish Victor 52.6; Banner 51.1; Gold Rain 51.0; Minnesota 26, 47.8; Swedish Select 44.5; and Kherson 40.3. In addition, one other commercial variety, Dibbles Heavy Weight, was tested for the first time. This gave 43.8 bushels per acre.

Ten varieties of our breeding were also tested. Five of these were varieties which have been tested for the past four years. These varieties with their yields are as follows: Maine 340, 52.7 bushels; Maine 355, 51.4 bushels; Maine 281, 51.5 bushels; Maine 351, 51.1 bushels; Maine 337, 48.2 bushels. The other five varieties were new strains which were tested under field conditions for the first time this year. These varieties and their yields are No. 1054, 51.5 bushels; No. 891, 47.4 bushels; No. 1053, 46.7 bushels; No. 978, 46.5 bushels; No. 982, 45.0 bushels.

From these records it will be seen that all of the varieties yielded much lower than in the past. The highest yield obtained was from Early Pearl, 56.7 bushels. Maine 340 was second in yield, giving 52.7 bushels per acre. Two of the plots of Maine 340 were very seriously injured by the heavy rains, and this in a large measure accounts for its smaller relative yield. Several other varieties such as Gold Rain and Minnesota 26 which have usually stood near the top of the list yielded much lower relatively this year than in the past.

The 5 pure lines including Maine 340, Maine 355, etc., averaged to yield better than the majority of the varieties tested. Of the five new varieties tested for the first time only one—No. 1054—appears to be promising, but some of these will be tested again next year.

RATE OF SEEDING OATS IN AROOSTOOK COUNTY.

It is the prevailing custom in Aroostook County to seed very heavily with oats. Perhaps the majority of the farmers sow from 4 to 6 bushels to the acre. It has been the experience in other parts of the country and even in other parts of the State that this is too much seed for the best results. From 2 to 3 bushels per acre have given the best results in the southern part of the State.

In 1914 some preliminary rate of seeding experiments were carried out on Aroostook Farm. The results were reported in Bulletin 236. Injury to certain of the plots, however, made the interpretation of the results somewhat doubtful. In 1915 these experiments were repeated upon duplicate plots under much more favorable conditions. The results of these tests were published in Bulletin 246.

In 1916 the same experiment was again repeated, using triplicate 1-10 acre plots for each rate of seeding. The conditions under which the 1916 experiments were carried out were similar to those in 1915. Six different rates of seeding were used, ranging from 2 to 5 bushels per acre. The land was in potatoes in 1915. The seeding was done with a large disk drill. Owing to the loose texture of the ground the land was rolled before seeding and also immediately afterwards. This prevented too deep seding which sometimes occurs with the use of a heavy disk drill in the loose soil of Aroostook. Commercial fertilizer (5-8-0) was applied broadcast before seeding at the rate of 500 pounds per acre. The seed used in 1916 was the variety known as Maine 340. In the preceding year the Prosperity variety had been used.

The results of the experiment calculated to acre yields are given in the tables that follow.

Rate of Seeding Experiment, 1916.
Yields of grain and straw per acre.

Plot No.	Rate of Seeding Per Acre	Oats Bushels	Straw Pounds
464	8 Pecks	62.6	4532
470	8 "	73.9	5044
476	8 "	72.2	5697
Average		69.6	5091
465	10 "	64.0	3617
471	10 "	71.3	5343
477	10 "	77.3	3731
Average		70.9	4231
466	12 "	63.3	3775
472	12 "	81.4	3932
478	12 "	78.3	3668
Average		74.3	3769
467	14 "	70.4	3758
473	14 "	73.7	3965
479	14 "	82.9	3883
Average		75.7	3868
468	16 "	77.3	4172
474	16 "	77.3	3834
480	16 "	82.7	4760
Average		79.1	4256
469	20 "	84.8	5458
475	20 "	70.8	4434
481	20 "	80.0	4412
Average		78.5	4768

Rate of Seeding Experiment.
Average of the oat yields for two years.

Rate of Seeding Per Acre	Oats Bushels	Straw Pounds
8 pecks	61.5	3720
10 pecks	62.4	2870
12 pecks	67.6	3068
14 pecks	71.3	3187
16 pecks	70.2	3238
20 pecks	69.5	3334

These results indicate that there is really no significant difference in the yields when 14, 16 or 20 pecks are sown. There is, however, a distinct disadvantage in the higher rates of seeding. This lies in the greater tendency to lodge. With the heavier rates of seeding the straw tends to be smaller in diameter and never becomes so hard as in the more open growth

of a lighter seeding. In each year we have noted that the plots with 20 pecks per acre were more likely to lodge than the others.

It is expected that these experiments will be repeated next year since it is only from the average yields over a period of years that definite conclusions can be drawn.

EFFECT OF OMITTING POTASH FERTILIZATION UPON THE OAT CROP.

Owing to the shortage of potash caused by the war it is very important to have as much information as possible regarding the value of this element for various crops. In 1915 the Maine Agricultural Experiment Station began a series of experiments at Aroostook Farm with the object of determining the value of potash for potatoes. In general these results have shown that there is sufficient available potash in Aroostook soils to mature a profitable crop of potatoes. Nevertheless the addition of relatively small amounts of potash has resulted in a marked increase in yield.

In order to obtain some information relative to the value of potash for oats two series of experiments were carried on at Aroostook Farm this year. In each series duplicate 1-40 acre plots of oats were grown with 5 different mixtures of fertilizer varying in potash from 0 to 8 per cent. Each mixture contained 4 per cent of nitrogen and 8 per cent available phosphoric acid. The fertilizer was broadcasted before seeding at the rate of 500 pounds per acre. The seed used was of the variety known as Maine 340, an oat bred by the Maine Agricultural Experiment Station and regarded as one of the best varieties so far obtained for Maine. Series No. 1 was grown on land which was in potatoes without potash in 1915 and Series 2 was on land which had potatoes with 7 per cent potash in 1915.

The yields are given in the tables that follow.

Yields Per Acre in No Potash Experiment with Oats, 1916. Series I, on Land with No Potash in 1915.

Plot No.	Amount of Potash 1916	Yield of Straw In Pounds	Yield of Grain In Bushels
412	None	4590	71.6
417	None	3180	65.6
Average		3885	68.6
413	None + common salt	4510	71.6
418	None + common salt	2980	59.4
Average		3745	65.5
414	2 per cent potash	4420	70.6
419	2 per cent potash	3300	61.9
Average		3860	66.3
415	5 per cent potash	4420	76.9
420	5 per cent potash	2824	57.5
Average		3622	67.2
416	8 per cent potash	3980	71.9
421	8 per cent potash	3360	66.3
Average		3670	69.1

Yields Per Acre in No Potash Experiment with Oats, 1916. Series II, on Land with 7 per cent Potash in 1915

Plot No.	Amount of Potash 1916	Yield of Straw In Pounds	Yield of Grain In Bushels
422	None	3424	63.8
427	None	4110	74.1
Average		3767	68.9
423	None + common salt	3930	67.2
428	None + common salt	3500	68.1
Average		3715	67.7
424	2 per cent potash	3280	68.8
429	2 per cent potash	2160	60.0
Average		2705	64.4
425	5 per cent potash	3370	72.2
430	5 per cent potash	2640	63.8
Average		3005	68.0
426	8 per cent potash	3380	74.4
431		2980	61.9
Average	8 per cent potash	3140	68.1

The average yield of grain in bushels per acre from the plots on the soil with the two different treatments in 1915 are as follows.

1916 Treatment	No Potash in 1915	7% Potash in 1915
No Potash	68.6	68.1
No Potash + salt	65.5	67.7
2 per cent potash	66.3	64.4
5 per cent potash	67.2	68.0
8 per cent potash	69.1	68.1

It is seen at once that there is no significant difference between any of these yields. The average yield of the plots on land without potash in 1915 is exactly the same as the yield on land with 7 per cent potash in 1915. The application of potash the year before, therefore, did not affect the yield of oats. Furthermore, in each series the yield of the plots without potash in 1916 is as high as that of the plots with 7 per cent potash. Some of the intermediate plots show slightly decreased yields but in no case is the difference great enough to be significant.

So far as the results of a single year are concerned, it would appear that on Aroostook soil potash is not a limiting factor in the production of oats. However, too much reliance cannot be placed on a single year's results. It is quite possible that under different seasonal conditions and on different soils quite different results would be secured.

The experiment is to be repeated in 1917.

EFFECT OF OMITTING POTASH FERTILIZATION UPON THE POTATO CROP.

Since the introduction of potash in commercial fertilizers in the early seventies of the last century, many experiments have been made and many treatises written showing the value of potash in crop growing. The experimental data on growing crops without potash are very few.

Potatoes are the chief cash crop grown in Maine. It is of first importance for the growers to have what facts are available relative to the likelihood of obtaining a crop in 1916 without the application of potash. Foreseeing the possibility that, with the continuance of the war, very little potash would be available for fertilizers, the Maine Agricultural Experiment Station began in 1915, at Aroostook Farm, a series of experiments to determine the effect of different amounts of potash. The results obtained in 1915 were published both in the newspapers and in Bulletin 246.

In 1916 these experiments were repeated on 2 different lots of land. The first series of plots was on land which had been in grass for 2 years. The second series was on land which was

in grain for the 2 preceding years, and in each year had received 500 pounds per acre of a fertilizer carrying 7 per cent potash. On account of the difference in treatment of the preceding crops these 2 series of plots will be considered separately.

Five different mixtures were used. In each case the fertilizers contained 4 per cent of nitrogen (5 per cent of ammonia) of which one-third was in the form of nitrate of soda, and 8 per cent of available phosphoric acid. The potash varied as follows: On one plot there was no potash. The next plot also had no potash but common salt was mixed with the fertilizer at the rate of 300 pounds of salt per acre. The salt was used to see whether this would aid in freeing potash already in the soil but not in a form available for plant food. The fertilizer for the remaining three plots contained respectively 2 per cent, 5 per cent and 8 per cent potash. In each case the fertilizer was applied at the time of planting, at the rate of 1500 pounds per acre. Each plot was slightly less than one-half acre in area. The area of each plot was obtained by actual measurement and the yields are based on the weighed potatoes from each plot. Norcross potatoes were used for seed. Other than in respect to potash all plots were treated exactly alike.

Series I. The land on which this series of plots was located was in potatoes in 1912. It had been in grass for 2 years without any fertilizer. The following are the results obtained, expressed in yields per acre.

Yields per Acre in No Potash Experiment With Potatoes, Series I.

Plot No.	Amount of Potash	Merchantable		Culls	
		Bbls.	Bus.	Bbls.	Bus.
436	None	134.2	287	4.6	13
437	None + common salt	116.7	321	3.0	8
438	2 per cent	154.9	423	2.0	6
439	5 per cent	153.6	429	1.7	5
450	8 per cent	145.7	401	3.1	9

Series II. The land on which this series of plots was located was in potatoes in 1913. In both 1914 and 1915 this

field was in grain. In each year 500 pounds per acre of a 4-8-7 fertilizer was applied to the grain. In both years this field was laid out in experimental plots, involving a number of pathways. These pathways were kept cultivated and it is probable that a considerable residue of phosphoric acid and potash remained in the soil. This year these plots were planted with the same mixtures and handled in the same way as those in Series I. The land, however, was not naturally such good potato soil as that in Series I. The following are the results expressed in yields per acre of merchantable potatoes.

Yield per Acre in No Potash Experiment With Potatoes, Series II.

Plot No.	Amount of Potash	Merchantable		Culls	
		Bbls.	Bus.	Bbls.	Bus.
450	None	119.9	330	5.8	16
451	None + common salt	120.5	331	3.2	9
452	2 per cent	116.9	321	2.9	8
453	5 per cent	118.3	325	2.4	7
454	8 per cent	137.3	378	3.3	9

The yield in barrels for the two years from the three series of trials are given in the following table.

No Potash Experiment with Potatoes, 1915 and 1916. Yield in Barrels per Acre.

Amount of Potash	1915	1916		Average
		Series I	Series II	
None	110	104	120	111
None + common salt	—	117	121	119
2 per cent	116	154	117	129
5 per cent	116	154	118	129
8 per cent	120	146	137	134

Discussion of Results

The 1915 results showed that while there was a consistent increase of yield with the use of potash, nevertheless a profitable yield of potatoes was obtained without its use. Last year the plots without potash averaged to yield at the rate of 110 barrels per acre, while the plots with 8 per cent potash gave 120 barrels.

The yields on the different plots in Series I for 1916 show that the addition of potash has resulted in a very marked increase in yield. There are some irregularities in that the 8 per cent potash yielded slighly less than either the 2 or the 5 per cent. These differences are probably only random fluctuations due to irregularities of the soil. It must be remembered that field experiments of this kind are at their best very rough comparison. Such fluctuations are to be expected unless a series of replicate plots are used. A crude comparison of the effect of potash on this soil may be made by averaging the yield of the three plots which had potash and comparing with the average yields of the two plots which had no potash. The three plots averaged 152 barrels per acre, while the two no-potash plots averaged 110 barrels per acre. At the current prices of potatoes in Aroostook at harvest this means a difference of about $100 per acre. There seems to be no question but that the addition of potash to this kind of land was a very paying proposition under the seasonal condition of this year.

It will be noted that in the case of Series II, 1916, there is no such marked increase due to the addition of potash as was found in the former series. The first four plots show no significant difference in yield. The fifth plot on which an 8 per cent potash was used shows an increase of nearly 20 barrels per acre over the preceding. Whether this increase is due to the extra potash alone, or whether it is partly due to soil differences cannot be ascertained. It seems very probable that there was a considerable residue of potash in the soil from the preceding crops and that this amount was sufficient to obscure any possible differences in yield due to application of small amounts of potash in 1916.

From the results of these 3 trials in 2 seasons the following tentative conclusions may be drawn: First, that the addition of

as little as 45 pounds per acre of potash increased the yield of potatoes at least when grown on sod land. The amount of this increase depends upon the condition of the land and probably also upon the seasonal conditions. The results obtained this year on sod land indicate that it paid to use goods with 2 per cent potash even at the present abnormal price. Second, a profitable yield of potatoes can be obtained without the use of potash for at least one year. If it should happen that potash is absolutely unobtainable, growers may still plant on land that is in good heart with the prospect of obtaining a profitable yield.

SULPHATE OF AMMONIA COMPARED WITH NITRATE OF SODA AS A SOURCE OF NITROGEN IN POTATO FERTILIZERS AT AROOSTOOK FARM.

A few years ago there was quite a general failure of the crop of potatoes in Aroostook County where a certain brand of fertilizer was used. This fertilizer was analyzed by the Station chemists and found to be high grade. While it was not quite up to its guaranty in some particulars it did carry enough nitrogen, phosphoric acid and potash to more than grow a good crop of potatoes. This fertilizer carried none of its nitrogen in the form of nitrate of soda, but it was all in the form of sulphate of ammonia and high grade organic materials. This led to the stronger reaffirming of the position which the Station had taken relative to the use of nitrate nitrogen in the potato crop. In earlier publications it has been pointed out that the potato makes its demands for nitrogen early in the season and that in the cold, late springs so common in Aroostook County, the crop demands that part of the nitrogen should be immediately available. For this reason the Station has strongly urged that about one-third of the nitrogen in a potato fertilizer be nitrate nitrogen.

In the process of making gas and coke from coal there is developed a large amount of sulphate of ammonia, which in many coke and gas plants is still going to waste. In some plants this now is being conserved and many thousand tons of sulphate of ammonia are thus obtained each year. With the in-

creasing use of high grade organic nitrogen for food of animals, the price of tankage has been going higher and higher year by year. It is, of course, desirable, if it can be done, that as much as possible of this sulphate of ammonia, which is a comparatively cheap source of nitrogen, be used in Maine fertilizers.

Because of these facts, arrangements were made to begin in 1914 a series of experiments to run over a period of several years. The "base" which was used in these goods was made by the wet process, whereby nitrogen from rather low grade goods is made as available as from high grade goods. The available phosphoric acid was furnished in the form of acid phosphate and the potash in the form of sulphate of potassium. The fertilizer was free from chlorides so as to preclude the possibility of the formation of poisonous ammonium chloride. The base carried approximately one-third of the nitrogen that went into the formula. The remainder of the nitrogen was furnished in the form of nitrate of soda and sulphate of ammonia, as indicated in the following plan:

Plot 1. Basal mixture and 2-3 of the nitrogen in form of nitrate of soda.

Plot 2. Basal mixture and 2-3 of the nitrogen in form of sulphate of ammonia.

Plot 3. Basal mixture and 1-3 of the nitrogen in form of nitrate of soda and 1-3 in form of sulphate of ammonia.

Plot 4. Basal mixture and 1-3 of the nitrogen in form of high grade organic and 1-3 in form of nitrate of soda.

Plot 5. Basal mixture and 1-3 of the nitrogen in form of high grade organic and 1-3 in form of sulphate of ammonia.

In each case the finished fertilizer analyzed 4 per cent nitrogen, 8 per cent available phosphoric acid and 7 per cent potash. In each year the fertilizer has been applied in the planter at the rate of 1500 pounds per acre. Other than the fertilizer used the plots were planted, cultivated, sprayed and cared for in all particulars alike. In each year duplicate plots each about one-half acre in area have been grown with each mixture.

The results for 1914 and 1915 are reported in detail in Bulletin 246. The detailed results of the experiment for 1916 are given in the table which follows.

Sulphate of Ammonia and Nitrate of Soda Experiment.
Yield of Potatoes per Acre.

Plot No.	Treatment	Merchantable		Culls	
		Bbls.	Bus.	Bbls.	Bus.
441	$\frac{2}{3}$ nitrate of soda	130.6	359	27.5	21
455	$\frac{2}{3}$ nitrate of soda	150.1	412	2.6	7
Average		140.3	385	5.0	14
442	$\frac{2}{3}$ sulphate of ammonia	135.8	373	4.9	14
456	$\frac{2}{3}$ sulphate of ammonia	143.5	395	4.2	12
Average		139.6	384	4.1	13
443	$\frac{1}{3}$ nitrate of soda, $\frac{1}{3}$ sulphate of ammonia	131.0	360	6.1	17
457	$\frac{1}{3}$ nitrate of soda, $\frac{1}{3}$ sulphate of ammonia	143.7	378	1.8	5
Average		137.3	369	4.0	11.0
444	$\frac{1}{3}$ nitrate of soda, $\frac{1}{3}$ organic	136.6	376	4.7	13
458	$\frac{1}{3}$ nitrate of soda, $\frac{1}{3}$ organic	144.34	397	1.6	4.4
Average		140.5	386	3.1	8.6
445	$\frac{1}{3}$ sulphate of ammonia, $\frac{1}{3}$ organic	142.4	392.71	6.9	18.9
459	$\frac{1}{3}$ sulphate of ammonia, $\frac{1}{3}$ organic	144.1	396.22	1.1	2.9
Average		143.3	392.97	4.0	10.9

From the above table it will be seen that the yields from these different mixtures were exceedingly uniform. There is only 6 barrels per acre difference between the best and the poorest yielding mixture and in field experiments of this kind such a small difference has no significance.

The result for the 3 years of the experiment are given in the following table.

Sulphate of Ammonia and Nitrate Soda Experiment 1914, 1915 and 1916
Yield in Barrels Per Acre.

Treatment	1914	1915	1916	Average
$\frac{2}{3}$ nitrate of soda	120	113	140	125
$\frac{2}{3}$ sulphate of ammonia	110	120	140	123
$\frac{1}{3}$ nitrate of soda, $\frac{1}{3}$ sulphate of ammonia	116	119	137	124
$\frac{1}{3}$ nitrate of soda, $\frac{1}{3}$ organic	120	111	140	124
$\frac{1}{3}$ sulphate of ammonia, $\frac{1}{3}$ organic	110	109	143	121

From the results of these 3 years it appears that at least 2-3 of the total nitrogen can be supplied in the form of sulphate of ammonia without decreasing the yield. It is planned to continue these experiments in order to determine the effect of these different substances under a number of different seasonal conditions.

METHOD OF APPLICATION OF FERTILIZER UPON POTATOES AT AROOSTOOK FARM.

It has always been more or less customary in growing potatoes in Maine to apply the fertilizer in the drill or hill at the time of planting. This was largely the practice when farm manures were used in connection with potato growing and has been followed with commercial fertilizers. Although now when farm manures are used in connection with potatoes they are more likely to be applied broadcast and a smaller amount of fertilizer applied in the drill. There was little question in the minds of practical growers that when 500 to 1000 pounds of fertilizer were applied per acre that it was to the best advantage to apply it in the drill. With the increase up to 1,500 to 2,000 pounds per acre the question has arisen whether it may not be advisable to apply the fertilizer at different times. This led the Station to undertake a series of trials at Aroostook Farm.

In 1914 an experiment was started to extend over a period of years for the purpose of testing the method of applying fertilizer. Something over acre plots were used. Three plots were used in the experiment in 1914. To one plot all of the fertilizer was applied in the planter at planting. To another plot 1,000 pounds of fertilizer were applied at planting and 500 pounds when the potatoes were up. And to a third plot 1,000 pounds were applied broadcast before planting and 500 pounds in the planter at planting. The Lowell Strain of Green Mountain potatoes was used for seed. The crop was well cultivated and sprayed.

The experiment was repeated in 1915 and a plot was added to which all of the fertilizer was applied broadcast before plant-

ing. The experiment was again repeated in 1916, using duplicate plots of about one-half acre each.

The fertilizer used each year was high grade, carrying 4 per cent nitrogen, 8 per cent available phosphoric acid and 7 per cent water soluble potash. One-third of the nitrogen was in the form of nitrate of soda, and the remainder was high grade organic nitrogen. The yields are based upon weighings and not upon measure. The potatoes were clean, without adhering soil.

In potato experiments at Highmoor Farm the Station had found that when there was only a small amount of rainfall following the second application of fertilizer that apparently this added fertilizer was not well utilized. Each season, however, at Aroostook Farm there was ample water to dissolve and render the plant food in all of the fertilizer available. It has been estimated that it takes about 6 inches of water to successfully grow a crop of potatoes. The rainfall in each of the years 1914 and 1915 totaled over 12 inches in May, June, July, and August, and in 1916 over 11 inches in these months.

The results obtained in 1914 and 1915 are reported in detail in Bulletin 246. The yields per acre obtained in 1916 are as follows:

Yield per Acre Obtained in Method of Applying Fertilizer Experiment, 1916

Plot No.	Treatment	Merchantable		Culls	
		Bbls.	Bus.	Bbls.	Bus.
446	1500 lbs. in planter	141.8	399	5.7	16
460	1500 lbs. in planter	145.5	400	1.0	3
Average		143.7	396	3.3	9
447	1000 lbs. in planter, 500 lbs. when up	139.3	383	2.8	8
461		140.3	386	2.5	7
Average		139.8	384	2.7	7
448	1000 lbs. broadcast, 500 lbs. when up	130.4	358	0.6	2
462		129.7	356	1.5	5
Average		130.0	357	1.1	3
449	1500 lbs. broadcast	134.6	370	1.0	3
463	1500 lbs. broadcast	127.6	351	0.5	1
Average		131.1	360	0.8	2

These results indicate that the best yields are obtained when all or a large part of the fertilizer is applied in the planter. The results this year are much more marked than in the 2 preceding years. In fact, the results of the first two years indicated that there was little to choose between the methods so far as yield was concerned.

The yield of merchantable potatoes stated in barrels for the three years is given in the table that follows.

Method of Applying Fertilizer 1914, 1915 and 1916. Yield in Barrels per Acre.

Method	1914	1915	1916	Average
1500 pounds in planter	131	109	144	128
1000 pounds in planter, 500 pounds when up	124	113	140	122
1000 pounds broadcast, 500 pounds when up	123	109	130	121
1500 pounds broadcast	—	113	131	122

From these results it seems quite clear that fully as good, if not better, yields are obtained by applying all of the fertilizer in the planter. As this method is much cheaper and more convenient than any of the others it is the one to be recommended. It seems that at least up to 1500 pounds per acre nothing is to be gained either by broadcasting fertilizer before planting or by applying a part at the first cultivation.

SALT AS A FERTILIZER

In the experiments with oats (page 109) and potatoes (page 111) salt was used in connection with nitrogen and phosphoric acid without potash. No decisive results were obtained.

In cooperation with the county demonstrators in Hancock and Washington Counties, salt was tried on grass, potatoes and turnips. An experiment with M. S. Lyons of Calais on grass showed no effect from the use of salt in top dressing. Experiments with I. R. Sprague of Princeton, John Grasse at Lubec and Fred A. Tyler at Prescott with potatoes gave on the whole a slightly smaller yield in the plots where salt was applied than where there was no application. In case of Mr. Tyler, he had

quite a large percentage of rot, and there seemed to have been less rot and rather more sound potatoes on the plots where the salt was used. Hence, his experiments showed a gain in the use of salt, but nothing decisive.

Salt tests were made with turnips with C. L. Pottle, Perry; F. P. Washburn, Perry; and E. M. Scott, Perry. Mr. Scott's experiment was a failure because of the exceedingly wet weather. There was a gain from the use of salt of 48 barrels per acre in the case of Mr. Washburn, and 24 barrels per acre in Mr.Pottle's case. This is in accord with experiments running over a long series of years at the Rothamsted Experiment Station in England, where salt was found uniformly to be of benefit as a fertilizer for turnips. This does not seem to be due to the fact that it freed potash, but that common salt is an essential factor in the successful growing of turnips.

With oats, grass and potatoes no benefit has been found in the few trials made at this Station from the application of common salt. With turnips increased yields have been obtained from the application of salt. These experiments are not extensive enough or sufficiently carefully planned and carried out to warrant definite conclusions, but they do not indicate any appreciable effects of common salt as a liberator of potash of the soil.